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FINAL REPORT
JULY 1991

REPORT NO. 91-13

MIL-STD-398 TEST OF NET WEIGHT FILLING SYSTEM BARRICADE

Prepared for:
Lone Star Army Ammunition Plant
ATTN: SMCLS-SF
Texarkana, TX 75501-9101

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The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by Lone Star Army Ammunition Plant (LSAAP), Texarkana, TX to provide MIL-STD-398, Military Standard Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance, instrumentation services for measuring blast overpressure and thermal flux produced by igniting 6.25 pounds of M10 propellant in the net weight filling system barricade. This amount of explosives duplicated the maximum amount, plus a 25 percent safety overload, which is outlined for use in actual production. A maximum credible incident (MCI) was defined by LSAAP as a detonation of 6.25 pounds of M10 propellant. Based on this criteria, two blast pressure gages were placed at the loading door of the barricade, and the other at the filling position. Thermal flux gages were also placed at the same positions as the blast overpressure gages. A third thermal flux gage was placed at the side facing the dump chute. (continued on back)

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19. Abstract (continued).

The test charge was functioned, then the blast pressure and thermal flux recorded. Blast overpressure levels were too low in amplitude to record. Thermal flux radiation was also too low to record. As a result, the net weight filling system met the test requirements of MIL-STD-398, Military Standard Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance.

U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
VALIDATION ENGINEERING DIVISION
SAVANNA, IL 61074-9639

REPORT NUMBER 91-13
MIL-STD-398 TEST OF NET WEIGHT FILLING SYSTEM BARRICADE

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PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS) was tasked by Lone Star Army Ammunition Plant (LSAAP), Texarkana, TX to provide MIL-STD-398, Military Standard Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance, instrumentation services for measuring blast overpressure and thermal flux produced by igniting 6.25 pounds of M10 propellant in the net weight filling system barricade. This amount of explosives duplicated the maximum amount, plus a 25 percent safety overload, which is outlined for use in actual production. A maximum credible incident (MCI) was defined by LSAAP as a detonation of 6.25 pounds of M10 propellant. Based on this criteria, two blast pressure gages were placed at the loading door of the barricade, and the other at the filling position. Thermal flux gages were also placed at the same positions as the blast overpressure gages. A third thermal flux gage was placed at the side facing the dump chute. The test charge was functioned, then the blast pressure and thermal flux recorded. Blast overpressure levels were too low in amplitude to record. Thermal flux radiation was also too low to record. As a result, the net weight filling system met the test requirements of MIL-STD-398, Military Standard Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL 61299-6000. Reference is made to Change 4, 4 October 1974, to AR 740-1, 23 April 1971, Storage and Supply operations; AMCCOMR 10-17, 13 January 1986, Mission and Major Functions of USADACS.

C. OBJECTIVE. The objective of this test is to determine if the net weight filling system barricade meets the requirements of MIL-STD-398, Military Standard Shields, Operational for Ammunition Operations, Criteria for Design of and Tests for Acceptance; Methods 101, Blast Overpressure; 201, Fragment Retention; and 301, Heat Flux Measurement.

D. CONCLUSIONS:

1. Blast overpressure at the operator's position was less than 0.5 psi reflected and less than 0.5 psi reflected at the refilling controls position. No direct blast overpressure was recorded. The blast pressures recorded were below the 5.0 psi limit for reflected pressure.

2. The net weight filling system retained all internal fragments. An external fiberglass cover, used as an environmental cap on top of the shield, was disengaged and landed on the ground 17 feet from the barricade. The weight of the fiberglass cover was approximately 2 pounds, yielding 34 foot-pounds of work to move the 17-foot distance. These energetic levels were below the 50 foot-pound limit of AR 380-100.

3. Thermal flux radiation, recorded at the operator's position, was 0.10 Btu/sq. ft.-sec. and 0.70 Btu/sq. ft.-sec. at the refilling controls position. A third gage was placed at the dump chute, and it recorded 0.01 Btu/sq. ft.-sec. The amount of radiation was below the maximum limit of MIL-STD-398.

4. Blast overpressure and heat flux measurements indicated that the net weight filling system barricade satisfied the requirements of MIL-STD-398 in terms of blast overpressure, fragment retention, and thermal flux.

PART 2

ATTENDEES

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PART 3

TEST PROCEDURES

DETAILED REQUIREMENTS

100 Class - Blast Attenuation Tests

200 Class - Fragmentation Tests

300 Class - Thermal Effects Attenuation Tests

CLASS-100 BLAST ATTENUATION TESTS

METHOD 101 BLAST OVERPRESSURE MEASUREMENT

A. PURPOSE:

1. Measurement of blast overpressure is conducted to ensure that personnel are not exposed to peak positive incident overpressure greater than 2.3 psi when the operational shield is subjected to a maximum credible incident (MCI).

2. An acceptable alternative to meas' ring peak positive incident overpressure is to measure peak positive normal reflected overpressure. Personnel shall not be exposed to a maximum positive normal reflected overpressure greater than 5.0 psi when the operational shield is subjected to an MCI.

B. DESCRIPTION OF TEST. An MCI is created with the operational shield. Blast pressure gages are used to measure blast overpressure.

C. CRITERIA FOR PASSING TEST. The operational shield shall be considered adequate if it can be determined from a pressure-distance plot of the data that personnel will not be exposed to a peak positive incident overpressure above 2.3 psi or a peak positive normal reflected overpressure above 5.0 psi.

D. INSTRUMENTATION. Blast Pressure Gages and Electronic Recording System. Based on the equivalent test charge, weight of explosives, and anticipated peak overpressure, the instrumentation system shall have the necessary response time and bandwidth to acquire data. Instrumentation shall be calibrated in accordance with current procedures of TB 43-180, Calibration Requirements for the Maintenance of Army Materiel.

E. TEST PROCEDURES:

1. When the shield is tested in a simulated operational bay environment, overpressure readings shall be taken at the following locations:

(a) At the center of probable head locations of each operator. For standing locations, the gages shall be positioned 65 inches above the floor; for sitting locations, it shall be 31.5 inches above the seat.

(b) At representative positions where transient personnel may be located.

2. When testing is conducted in open air, position blast pressure gages around the shield in two or three concentric circles at distances where it is expected that overpressures of interest will be found. Stagger the gages so shock waves reaching the outer circles are not distorted by gages in the inner circle. The gages shall be placed at a height of 65 inches.

3. All instrumentation shall be within calibration at time of test.

4. If the shield is designed for use with more than one model or type of ammunition, select the item that would produce the maximum overpressure.

5. Apply an overload equal to 25 percent or more of the filler weight of the ammunition selected for the test, unless otherwise directed in an approved test plan.

6. All major explosive components should be fuzed separately to ensure simultaneous detonation or deflagration in order to simulate the MCI, unless otherwise directed in an approved test plan.

7. Function explosives and record overpressure readings.

8. Prepare pressure-distance plots from overpressure recordings.

CLASS - 200 FRAGMENT RETENTION TESTS

METHOD 201 FRAGMENT RETENTION TEST

A. PURPOSE. Fragment testing is conducted to verify that a prototype operational shield will:

1. Contain all fragmentation or direct fragmentation away from areas requiring protection.
2. Prevent generation of secondary fragmentation within areas requiring protection.
3. Prevent movement, overturning, or structural deflections which could result in personal injury.

B. DESCRIPTION OF TEST. An MCI is created to test the operational shield.

C. CRITERIA FOR PASSING TEST:

1. Contain all fragmentation or direct fragmentation away from areas requiring protection.
2. Prevent generation of secondary fragmentation within areas requiring protection.
3. Prevent movement, overturning, or structural deflections which could result in personal injury.

D. TEST EQUIPMENT. Still picture camera equipment.

E. TEST PROCEDURES:

1. Fragment Retention Test.

(a) If the shield is designed for use with more than one mode or type of ammunition, select that item which will have the greatest potential fragmentation or shape charge effect.

Equipment, or reasonable simulation thereof, which shall perform the intended function on the ammunition, shall be positioned to generate secondary fragments.

(b) Apply an overload equal to 25 percent or more of the filler weight of the ammunition selected for the test, unless otherwise directed in an approved test plan.

(c) All major explosive components should be fuzed separately to ensure simultaneous detonation or deflagration in order to simulate the MCI, unless otherwise directed in the approved test plan.

(d) Function explosives.

2. Post-Test Procedures:

(a) Examine the interior and exterior for evidence of fragments. Photograph the shield to document the results.

(b) Examine the shield for movement, overturning, or structural deflections which could result in personal injury.

(c) Shields designed for intentional detonation shall be examined for damage and an estimate made as to the ability of the shield to remain operational as specified in the design criteria.

CLASS - 300 THERMAL EFFECTS MEASUREMENT

METHOD 301 HEAT FLUX MEASUREMENT

A. PURPOSE. Heat flux measurement is a condition of measure that personnel are not exposed to a maximum radiant heat flux determined in the equation given in criteria for passing test of this standard.

B. DESCRIPTION OF TEST. An MCI is created. Heat flux transducers are used to measure radiant heat flux.

C. CRITERIA FOR PASSING TEST. The operational shield shall be considered acceptable if it can be determined from heat flux-distance and heat flux-time plots to the test data that personnel will not be exposed to a radiant heat flux rating exceeding the formula: F=1.0/[(0.62t)^0.7423] cal/cm^2-sec, where F is the thermal flux, T is the time in seconds.

D. INSTRUMENTATION. Heat Flux Transducers and Electronic Recording System. Based on the thermal flux expected at the location of the transducers, the instrumentation system shall have the necessary response time and bandwidth to acquire data. Instrumentation shall be calibrated in accordance with current procedures of TB 43-180, Calibration Requirements for the Maintenance of Army Materiel.

E. TEST PROCEDURES:

1. When the shield is tested in a simulated operational bay environment, heat flux readings shall be taken at the following locations:

(a) At the center of probable head locations of each operator. For standing locations the transducers shall be positioned 65 inches above the floor; for sitting locations it shall be 31.5 inches above the seat.

(b) At representative positions where transient personnel may be located.

2. In a free field test, flux values at various distances from the point of detonation can be estimated by the relationship: $O_1 \times d_1^2 = O_2 \times d_2^2$, where o=heat flux in Btu/in^2-sec, and d=distance from point of detonation.

3. All instrumentation shall be within calibration at time of test.

4. If the shield is designed for use with more than one model or type of ammunition, select the item for the greatest heat flux.

5. Apply an overload equal to 25 percent or more of the filler weight of ammunition selected for the test, unless otherwise directed in an approved test plan.

6. All major explosive components should be fuzed separately to ensure simultaneous detonation or deflagration in order to simulate the MCI, unless otherwise directed in an approved test plan.

7. Function explosives and record radiant flux readings.

8. Prepare heat flux-distance and heat flux-time plots from radiant flux recordings.

PART 4

LONE STAR ARMY AMMUNITION PLANT

TEST PROCEDURE

DZI DAY & ZIMMERMANN, INC. LONE STAR DIVISION DEFENSE SYSTEMS GROUP OPERATOR OF LONE STAR ARMY AMMUNITION PLANT TEXARKANA, TEXAS

EM-8500/QAT/DK
FEBRUARY 6, 1991

TECHNICAL PROGRAM LS 324

SUBJECT: TESTING OF PROPOSED BARRICADE FOR CONTAINMENT OF M10 PROPELLANT UTILIZED IN THE LOADING OF EXPULSION CHARGES DRAWING NUMBER EC-11856-0.

[illegible] THE PROPOSED BARRICADE WILL SATISFACTORILY COMPLY WITH MIL-STD 398 WHEN 6.25 POUNDS OF M10 PROPELLANT IS INITIATED INSIDE THE VESSEL. THIS AMOUNT OF EXPLOSIVES DUPLICATES THE MAXIMUM AMOUNT, PLUS A 25% SAFETY OVERLOAD, THAT IS OUTLINED FOR USE IN ACTUAL PRODUCTION.

DISCUSSION: THE BARRICADE, DRAWING NUMBER EC-11856, WILL BE UTILIZED TO HOUSE A HEIRATH ANDREWS TYPE CHECK WEIGHING DEVICE THAT WILL DISPENSE M10 PROPELLANT FOR THE EXPULSION CHARGE IN G-15, BAY 8. THE OPERATION IS CURRENTLY SCHEDULED FOR THIS LOCATION BUT WOULD NOT BE LIMITED TO THE PARTICULAR PRODUCTION SITE MENTIONED ABOVE. THE HEIRATH ANDREWS DISPENSER OPERATES WITH A PROGRAMMABLE TYPE CONTROLLER THAT ACTIVATES A VIBRATOR, WHICH IN TURN, RELEASES THE DESIRED AMOUNT OF M10 PROPELLANT. PRODUCTION PERSONNEL WOULD BE INVOLVED WITH THE DEVICE AND WOULD BE LOCATED IN CLOSE PROXIMITY TO THE UNIT. THE BARRICADE MUST PROVIDE OPERATOR PROTECTION AS OUTLINED IN MIL-STD-398 AND WILL REQUIRE THE ASSISTANCE OF USADACS PERSONNEL AND EQUIPMENT TO PROVIDE THERMAL FLUX AND BLAST OVERPRESSURE DATA. THE SUBJECT TEST DEVICE WILL BE POSITIONED IN XX-76 TEST AREA AND EQUIPPED WITH A FRANGIBLE TYPE ROOF OF WOOD AND FIBERGLASS AND WILL PROTRUDE BEYOND, OR THROUGH, THE TOP AS IT WILL IN THE ACTUAL PRODUCTION LOCATION. A SIMULATED HOPPER [illegible] AND MASS OF THE HEIRATH ANDREWS DISPENSE UNIT WILL BE PLACED INSIDE THE BARRICADE TO ASSIST IN EVALUATING FRAGMENT RETENTION. USADACS PERSONNEL WILL POSITION SENSORS AND TRANSDUCERS IN ACCORDANCE WITH ACTUAL OPERATOR POSITIONS THAT WILL BE INCURRED DURING USE. STILL PHOTOS WILL BE TAKEN PRIOR TO AND AFTER TESTING, AS WELL AS FASTEX FILM RECORDING THE EVENT.

PROCEDURE: THE TEST BARRICADE WILL BE POSITIONED AT XX-76 TEST SITE AS OUTLINED ABOVE AND FITTED WITH THE SIMULATED HEIRATH ANDREWS HOPPER. A #6 IRECO BLASTING CAP WILL BE POSITIONED INSIDE THE BARRICADE WITH THE LEAD WIRES RUN OUT THE BOTTOM DISPENSE PORT. THE TEST SUPERVISOR, OR TECHNICAL SPECIALIST, WILL THEN FILL THE HOPPER WITH 6.25 POUNDS OF M10 PROPELLANT AND NESTLE THE #6 IRECO BLASTING CAP INTO THE CHARGE. THE SERVICE DOOR WILL THEN BE CLOSED.

DZI DAY & ZIMMERMANN, INC. LONE STAR DIVISION DEFENSE SYSTEMS GROUP

TECHNICAL PROGRAM LS 324

THE FIELD LINES WILL BE SHUNTED AT THE CONNECTOR BOX AND CHECKED AT THE BARRICADE END FOR CONTINUITY AND EXTRANEOUS ELECTRICITY. IF THE CIRCUIT IS COMPLETE AND NO EXTRANEOUS ELECTRICITY IS DETECTED, THE LEAD WIRES AND FIELD LINE WILL BE CONNECTED. THE CIRCUIT WILL THEN BE CHECKED AT THE CONNECTOR BOX. IF NO DEFICIENCIES EXIST IN THE CIRCUIT, THE TEST SUPERVISOR WILL DETERMINE THAT ALL PERSONNEL ARE IN PROPER LOCATIONS AND WILL THEN INTRODUCE THE BLASTING MACHINE TO THE CIRCUIT AND ACTIVATE THE BLASTING CAP.

[illegible] ENSURE ADEQUATE INSULATION. THE CIRCUIT BOX AND THE BLASTING MACHINE WILL BE LOCKED AT ALL TIMES EXCEPT WHEN FIRING. THE KEY WILL BE IN THE POSSESSION OF THE TECHNICAL SUPERVISOR ONLY.

PERSONNEL LIMITS: ONLY THE TEST SUPERVISOR AND TECHNICAL SPECIALIST WILL BE ALLOWED IN THE VICINITY OF THE BARRICADE WHEN EXPLOSIVES ARE BEING INTRODUCED OR ELECTRICAL CONNECTIONS ARE BEING MADE AT THE TEST SITE. THE TECHNICIANS WILL BE LOCATED IN A BUNKER, AT A SAFE DISTANCE FROM THE TEST BARRICADE DURING TESTING. PHOTO LAB AND USADACS PERSONNEL WILL ALSO BE ALLOWED INSIDE THE BUNKER TO OPERATE RECORDING EQUIPMENT AND INSTRUMENTS. ALL OTHER PERSONNEL WILL BE LOCATED AT THE XX OFFICE BUILDING DURING THE TEST.

NOTE: BOTH THE CONTRACTOR AND THE ACO SAFETY OFFICES WILL BE NOTIFIED PRIOR TO THE TEST.

NOTE: STANDING ORDER #63 WILL BE FOLLOWED IN EVENT OF ANY UNUSUAL OCCURRENCE.

COORDINATOR:	**APPROVED BY:**
Dick King	Ronald E. Sinquefield
DICK KING	RONALD E. SINQUEFIELD

PART 5

TEST RESULTS

A. Blast Overpressure, Method 101:

1. At operator's position: Less than 0.5 psi.

2. At refilling controls: Less than 0.5 psi.

B. Fragment Retention Test, Method 201:

1. One fragment was produced as a result of this test. The fiberglass protective cover was separated from the top of the barricade and lodged on the ground 17 feet from the barricade.

2. Weight of the fiberglass panel was approximately 2 pounds, yielding 34 foot-pounds of work to move it 17 feet. The amount of energy was acceptable, based on the 50 foot-pound limit imposed by AMCR 385-100.

C. Heat Flux Measurements, Method 301:

1. At operator's position: 0.10 Btu/sq. ft.-sec.

2. At refilling controls: 0.10 Btu/sq. ft.-sec.

3. At dump chute: less than 0.10 Btu/sq. ft.-sec.

Note: Recorded blast pressures were reflected. No incident blast peak pressure was recorded.

PART 6

PHOTOGRAPHS

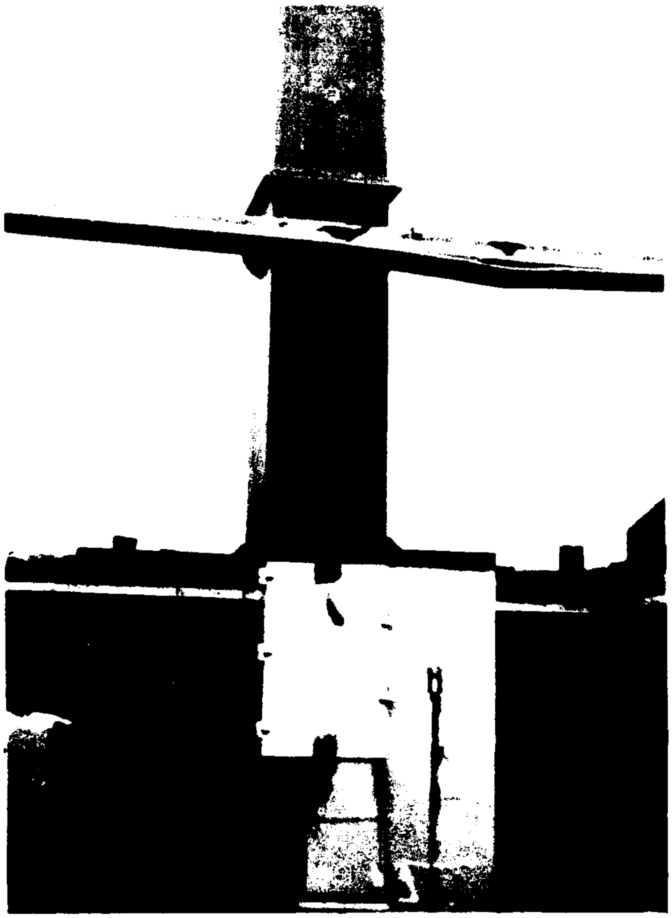

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Photo No. EVT-91-13-01. This photo shows the net weight filling system barricade which is used for filling expulsion charges with M10 propellant installed at the test site. The blast overpressure gage at the right is directed toward the operator's controls, located behind the hinged door. These controls are not installed in the barricade during testing. The transducer stand at the left is located at the operator's position. Both stands have blast overpressure and thermal flux transducers. A third transducer stand, placed behind the barricade, has only a thermal flux transducer.

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Photo No. EVT-91-13-04. This photo shows the net weight filling system barricade with the maintenance door open. The simulated hopper is shown with a cardboard wrap to build up the hopper height to accommodate the excess amount of M10 propellant.

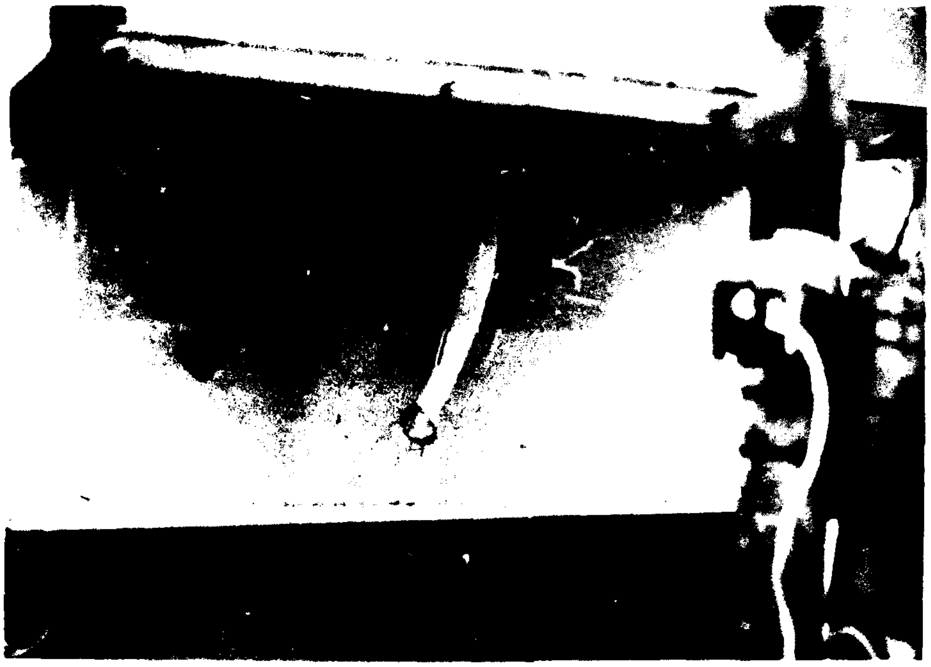

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Photo No. EVT-91-13-06. This photo shows the expulsion charge bag attached to the filling tube. A preweighed amount of M10 propellant was loaded into this bag. During operation, an operator held the bag on the filling tube. The lexan guard provided operator safety. The tube angling to the left was an overflow, or incorrect weight dump chute.

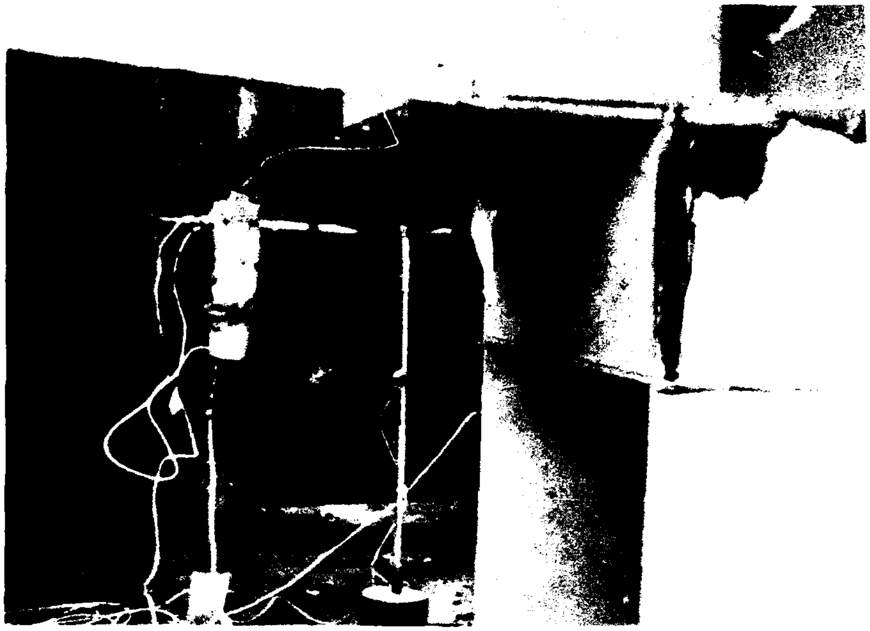

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Photo No. EVT-91-13-07. This photo shows the expulsion charge bag, blast overpressure, and thermal flux gages at the operator's position. A blast overpressure and thermal flux gage were placed at the lower edge of the lexan protective shield. The third thermal flux gage was placed in line with the dump chute.

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Photo No. EVT-91-13-11. This photo shows the inside of the net weight filling system barricade after functioning 6.26 pounds of M10 propellant. Functioning was accomplished with an electric match. The propellant burned in the hopper, charring the hopper and filler tube. The cardboard wrap burned. No propellant residue was found inside or outside of the barricade.

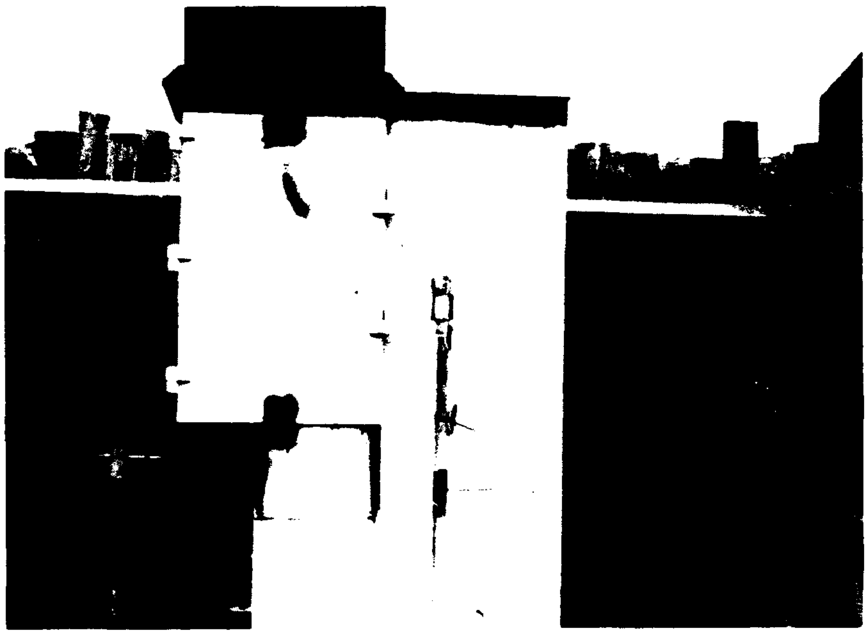

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Photo No. EVT-91-13-12. This photo shows the net weight filling system barricade after functioning 6.25 pounds of M10 propellant. No signs of leakage were found around the maintenance door.		

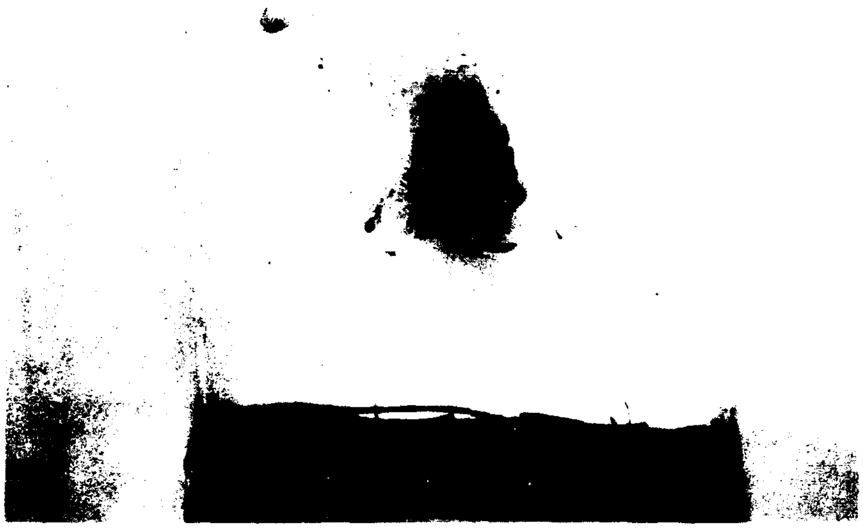

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Photo No. EVT-91-13-15. This photo shows the net weight filling system barricade after functioning 6.25 pounds of M10 propellant. This is a closeup of the loading position of the hopper filler tube. No leakage of gases produced by the burn was observed at the filler tube.

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. EVT-91-13-16. This photo shows the expulsion charge bag which was attached to the fill chute on the barricade. Note, there was no indication of powder residue after functioning 6.25 pounds of M10 propellant in the barricade.		